

WHAT IS CLAIMED IS:

1. A method of separating a target material from a suspension or dispersion, said method comprising the steps of:
combining a mass of magnetizable particles to said suspension or dispersion containing said target material for sufficient time for said target material to bind to said magnetizable particles, said magnetizable particles formed of a particle of crystallites of a magnetizable metal oxide and having a coating of a polysaccharide derivative having at least one pendant functional group, and a coupling group having an affinity for said target material; and
applying a magnetic field to said suspension or dispersion and separating said mass of said magnetizable particles and target material.
2. The method of claim 1, wherein said target material is an inorganic material, organic compound or biological material.
3. The method of claim 1, wherein said magnetizable particles comprise a mass of crystallites having a particle size of about 3 nm to about 25 nm.
4. The method of claim 1, wherein said magnetic particles have a particle size of about 50 nm to about 500 nm, said magnetic particles being readily dispersible in a liquid medium.
5. The method of claim 1, wherein said magnetic particles have a particle size of about 100 nm to about 450 nm, said magnetic particles being readily dispersible in a liquid medium.

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6. The method of claim 1, wherein said polysaccharide derivative is bonded directly to said particles of crystallites of said magnetizable metal oxide.

7. The method of claim 1, wherein said particles of said crystallites of said magnetizable metal oxide includes a coating of an organosilane bonded directly to said particles of said crystallites, and wherein said coating of said polysaccharide derivative is bonded to said organosilane.

8. The method of claim 1, wherein a purified complex of said magnetizable particles bound to said target material is dissociated and said magnetizable particles are removed by magnetic means to provide a substantially pure preparation of said target material.

9. The method of claim 1, wherein said magnetizable metal oxide is a magnetizable iron oxide.

10. The method of claim 1, wherein said magnetizable particles are prepared from precipitated magnetite which has been aged to increase the size of said aggregates.

11. The method of claim 1, wherein said magnetizable particles are produced by treating magnetizable aggregates with an acid, with a solution of a ferric salt, or with a base to form a colloidal suspension.

12. The method of claim 1, wherein said magnetizable particles are produced by treating magnetizable aggregates with a

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reactant selected from the group consisting of nitric acid, perchloric acid, a solution of ferric nitrate and tetramethylammonium hydroxide.

13. The method of claim 7, wherein said organosilane has a pendant functional group to which a polysaccharide or functionalized polysaccharide may be attached.

14. The method of claim 1, wherein said pendant functional group of the polysaccharide is a carboxyl group, a carbonate, an amino group or derivatized amino group, an aldehyde group, a sulfhydryl group, or a displaceable group such as a halide or a sulfonate.

15. The method of claim 1, wherein said pendant functional group of the polysaccharide is a carboxyl group attached to the polysaccharide through a linker having at least one heteroatom for every three carbon atoms in the linker.

16. The method of claim 15, wherein said heteroatom of the linker is O.

17. The method of claim 15, wherein said linker is derived from ethylene glycol, an oligoethylene glycol or a polyethylene glycol.

18. The method of claim 15, wherein said pendant functional group of the polysaccharide is introduced by reaction with chloroethoxyethoxyacetic acid and base.

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19. The method of claim 1, wherein said polysaccharide is dextran.

20. A method of producing magnetizable particles for separation of a target material, said method comprising the steps of:
providing aggregates of crystallites of a magnetizable metal oxide;

coating said aggregates with a polysaccharide derivative having pendant functional groups; and

coupling a coupling group to said functional group to form said magnetizable particles, said coupling group having a binding affinity for said target material and said magnetizable particles being dispersible in a liquid and being separable from a liquid applying a magnetic field.

21. The method of claim 20, further comprising the steps of dispersing said aggregates in a liquid and mixing said polysaccharide derivative with said liquid for a time sufficient to react said polysaccharide derivative with said aggregates to coat said aggregates.

22. The method of claim 20, wherein said aggregates comprise crystallites of said magnetizable metal oxide having a particle size of about 3 nm to about 25 nm.

23. The method of claim 20, wherein said magnetizable particles have a particle size of about 100 nm to about 450 nm.

24. The method of claim 20, further comprising the steps of

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dispersing said aggregate in a liquid reaction medium and adding an organosilane to said liquid reaction medium for a time sufficient to coat said aggregates, and form silane coated aggregates, and

thereafter coating said silane coated aggregates with said polysaccharide derivative.

25. The method of claim 20, wherein said magnetizable metal oxide is a magnetizable iron oxide.

26. The method of claim 20, wherein said aggregates are prepared by precipitating magnetite from a slurry which has been aged for a time sufficient to increase the size of said aggregates.

27. The method of claim 20, wherein prior to coating with said polysaccharide, said aggregates are treated with an acid, with a solution of a ferric salt, or with a base to form a colloidal suspension.

28. The method of claim 20, wherein said aggregates are treated with a reactant to form a colloidal solution, wherein said reactant is selected from the group consisting of nitric acid, perchloric acid, a solution of ferric nitrate and tetramethylammonium hydroxide.

29. The method of claim 20, wherein said organosilane has a pendant functional group to which a polysaccharide or functionalized polysaccharide may be attached.

30. The method of claim 20, wherein said pendant functional group of said polysaccharide is a carboxyl group, a carbonate, an

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amino group or derivatized amino group, an aldehyde group, a sulfhydryl group, a halide or a sulfonate.

31. The method of claim 20, wherein said pendant functional group of said polysaccharide is a carboxyl group attached to the polysaccharide through a linker having at least one heteroatom for every three carbon atoms in the linker.

32. The method of claim 31, wherein said heteroatom of the linker is O.

33. The method of claim 31, wherein said linker is derived from ethylene glycol, an oligoethylene glycol or a polyethylene glycol.

34. The method of claim 31, wherein said pendant functional group of the polysaccharide is introduced by reaction with chloroethoxyethoxyacetic acid and base.

35. The method of claim 20, wherein said polysaccharide is dextran.

36. A method for preparing discrete aggregates of a magnetic transition metal oxide, said method comprising the steps of:

dispersing transition metal ions in a liquid medium in the presence of a base in an amount to produce crystallites of said magnetic transition metal oxide having a particle size of about 3 nm to about 25 nm,

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thereafter aging said mixture for a time sufficient for the crystallites to form aggregates of said magnetic transition metal oxide having a particle size of about 50 nm to about 500 nm,

then converting said aggregates to a colloid by treatment with a reagent chosen from the group consisting of an acid, a base and a source of ferric ions, and subsequently removing the majority of the reagent.

37. The method of claim 36, wherein said magnetizable metal oxide is a magnetizable iron oxide.

38. The method of claim 36, wherein said crystallites of magnetizable iron oxide are prepared by the interaction of a solution of ferrous and ferric ions with a solution of ammonium hydroxide.

39. The method of claim 36, wherein treating said aggregates with acid, base, or ferric ion, removing a substantial portion of said acid, base or ferric ion, and dispersing said aggregates in dilute acid or dilute base forms a colloidal suspension.

40. The method of claim 36, comprising reacting said aggregates with an organosilane, removing excess organosilane, and dispersing said aggregates to form a colloid.

41. The method of claim 36, wherein prior to treatment with said organosilane, said method comprises converting said aggregates to a colloid by treating said aggregates with acid, base, or ferric ion, removing the majority of said acid, base or ferric ion, and dispersing the aggregates in dilute acid or dilute base to form said colloid.

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42. The method of claim 40, wherein said organosilane is an aminoalkyl- or aminoaryltrialkoxysilane.

43. The method of claim 40, wherein said organosilane is aminopropyltriethoxysilane.

44. A method of preparing an aminoarylpolysaccharide or an aminoalkylpolysaccharide, said method comprising the steps of:

forming a mixture of a polysaccharide and an alkyl azide or an aryl azide having a reactive functional group spaced from an azide group of said alkyl azide or aryl azide to form an azidopolysaccharide reaction product, and

adding a reducing agent to said azidopolysaccharide reaction product to reduce said azide group and form said aminoalkylpolysaccharide or aminoarylpolysaccharide.

45. The method of claim 44, comprising reducing azido group to an amino group with a stannous salt in the presence of an agent which prevents the precipitation of the resulting stannic ions.

46. The method of claim 45, wherein said stannous ion is used in the presence of a citrate buffer.

47. A polysaccharide with pendant carboxyl groups in which the carboxyl group is attached to said polysaccharide through a linker at least four atoms in length and having at least one heteroatom for every three carbon atoms in the linker.

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48. The method of claim 47, wherein said heteroatom of the linker is O.

49. The method of claim 47, wherein said linker is derived from ethylene glycol, an oligoethylene glycol or a polyethylene glycol.

50. The method of claim 47, wherein said pendant functional group of the polysaccharide is introduced by reaction with chloroethoxyethoxyacetic acid and base.

51. The method of claim 47, wherein said polysaccharide is dextran.

52. A kit for carrying out the separations of claim 1.

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